UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER DNA 5193F	2. GOVT ACCESSION NO. AD-A089 187	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SIMFIC: A SIMPLE, EFFICIENT FALLOUT PREDICTION MODEL		5. TYPE OF REPORT & PERIOD COVERED Final Report 16 Jan —31 Dec 79
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hillyer G. Norment		8. CONTRACT OR GRANT NUMBER(s) DNA 001-76-C-0010
9. PERFORMING ORGANIZATION NAME AND ADDRESS Atmospheric Science Associates P.O. Box 307 Bedford, Massachusetts 01730		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Subtask V99QAXNA001-02
11. CONTROLLING OFFICE NAME AND ADDRESS Director Defense Nuclear Agency Washington, D.C. 20305		12. REPORT DATE 31 Dec79
		13. NUMBER OF PAGES 82
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 5193F AD-E300 912		15. SECURITY CLASS (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE 81

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This work sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B325079464 V99QAXNA00102 H2590D.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Nuclear Fallout
Nuclear Weapons Effects
Fallout Modeling
Fallout Prediction
SIMFIC
DELFIC

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Details are given of the basis and mathematical structure of a fast, simple code, SIMFIC, for prediction of local fallout from surface and above surface nuclear weapon explosions. Verification results are presented for five test shot cases for which observed fallout patterns are available and which cover a yield range of 0.5 to 3380 KT. Prediction accuracy is as high as that obtained from the DELFIC code for these cases. Computing speed is on par with a code currently used for large-scale damage assessment studies. Other computing requirements are discussed briefly.

1. INTRODUCTION

A need has long been evident for a simple, fast numerical nuclear fallout prediction model with a capability approaching that of DELFIC,[1,2] but with greater accuracy and flexibility than WSEG-10.[3,4] Such a code could be used for operational work, such as damage assessment studies, and would be easily usable by those with less than total commitment to fallout research. A preliminary version of a model, SIMFIC (SIMplified Fallout Interpretive Code), that fills this need is described here. The physical and mathematical bases of the model are described in detail and validation results are presented. Computer requirements are discussed briefly. A complete description of the computer code is not included since at this time it is in a preliminary stage of development.

TABLE 4

COMPARISON OF OBSERVED AND PREDICTED FALLOUT PATTERN STATISTICS
Observed/DELFIC/SIMFIC

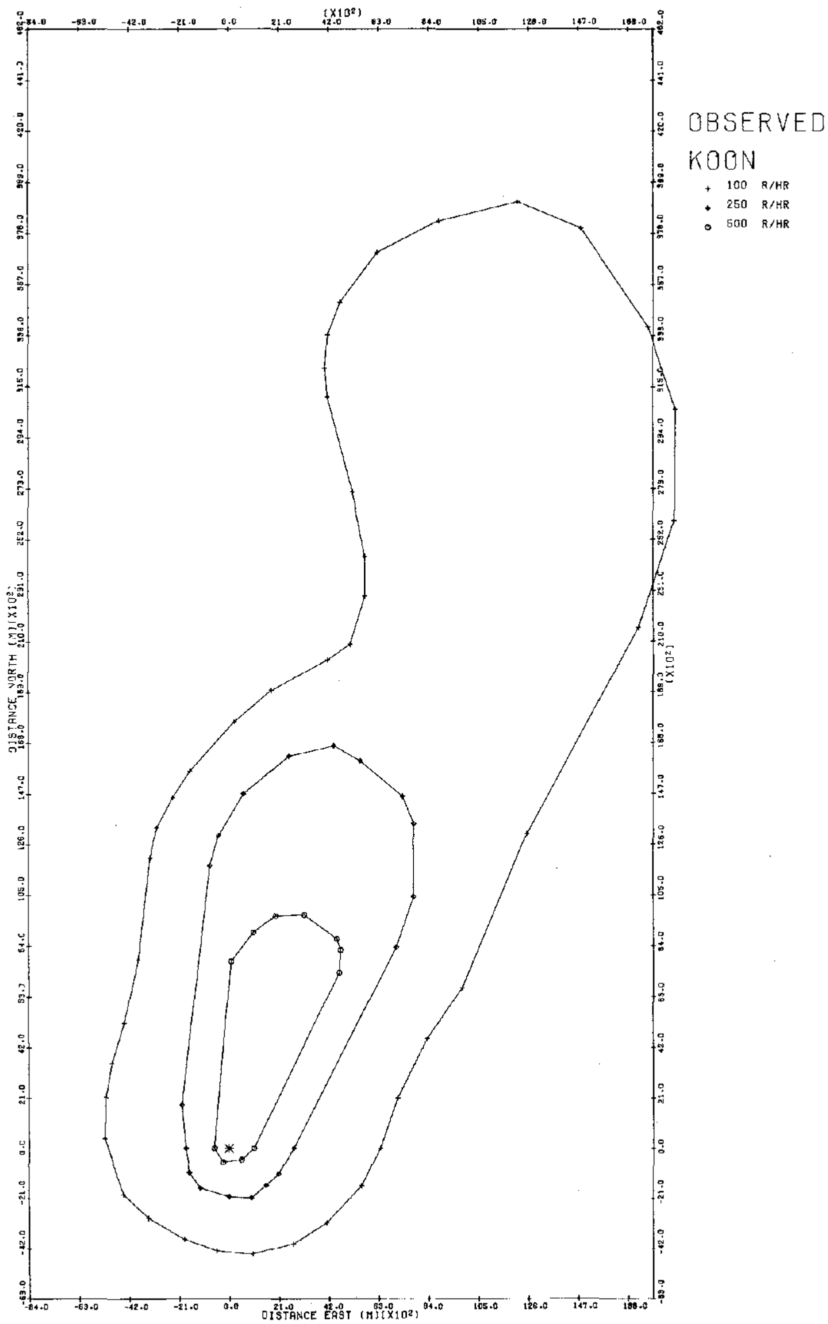
Test Shot	FM DELFIC SIMFIC	Contour (Roentgen hr^{-1})	Area(km^2)	Hotline Length(km)	Azimuth(deg)
Johnie Boy	0.182	1000	0.278/0.029/0.018	1.38/0.32/0.32	359/ 0/ 0
	0.152	100	0.539/0.774/0.781	2.73/2.58/2.69	345/344/344
		50	1.271/1.787/1.828	4.10/4.13/5.14	343/343/344
			58(42)/61(44)*	28(3)/34(13)*	
Jangle-S	0.483	500	0.117/0.144/0.156	0.69/1.00/1.60	342/353/351
	0.437	300	0.386/0.316/0.435	1.50/1.23/2.23	346/354/351
		100	1.437/2.242/1.278	3.74/5.87/3.40	1/355/352
		35	3.114/5.077/4.093	5.06/7.68/9.37	6/355/ 6
			40(45)/22(18)	43(42)/69(48)	
Small Boy	0.308	1000	0.216/0.047/0.144	1.00/0.25/0.60	71/ 66/ 80
	0.533	500	0.528/0.135/0.375	1.62/0.56/1.15	73/ 80/ 75
		200	0.942/0.564/1.031	2.22/1.69/2.17	72/ 73/ 71
		100	3.75/1.10/2.26	5.66/3.72/4.02	72/ 74/ 68
		50	9.03/4.38/7.59	8.10/6.47/8.17	75/ 72/ 66
			63(59)/25(24)	44(36)/20(15)	
Koon	0.287	500	32.0/26.0/44.0	10.2/12.5/14.9	18/ 0/ 0
	0.325	250	122/87.3/116	17.3/24.2/24.1	15/ 4/ 0
		100	550/261/374	41.0/39.5/41.6	17/ 3/ 1
			33(40)/25(18)	22(22)/29(20)	
Zuni	0.105	150	474/2239/2854	98/78/77	12/337/354
	0.189	100	2761/3619/4566	125/96/97	17/337/356
		50	6187/6660/9365	138/121/142	27/338/355
		30	10950/9913/15190	177/153/180	33/340/359
			105(16)/164(52)	17(16)/12(9)	

*Mean absolute percent errors: DELFIC/SIMFIC. The values in parentheses are calculated without including the data for the highest activity level contours. See footnote next page.

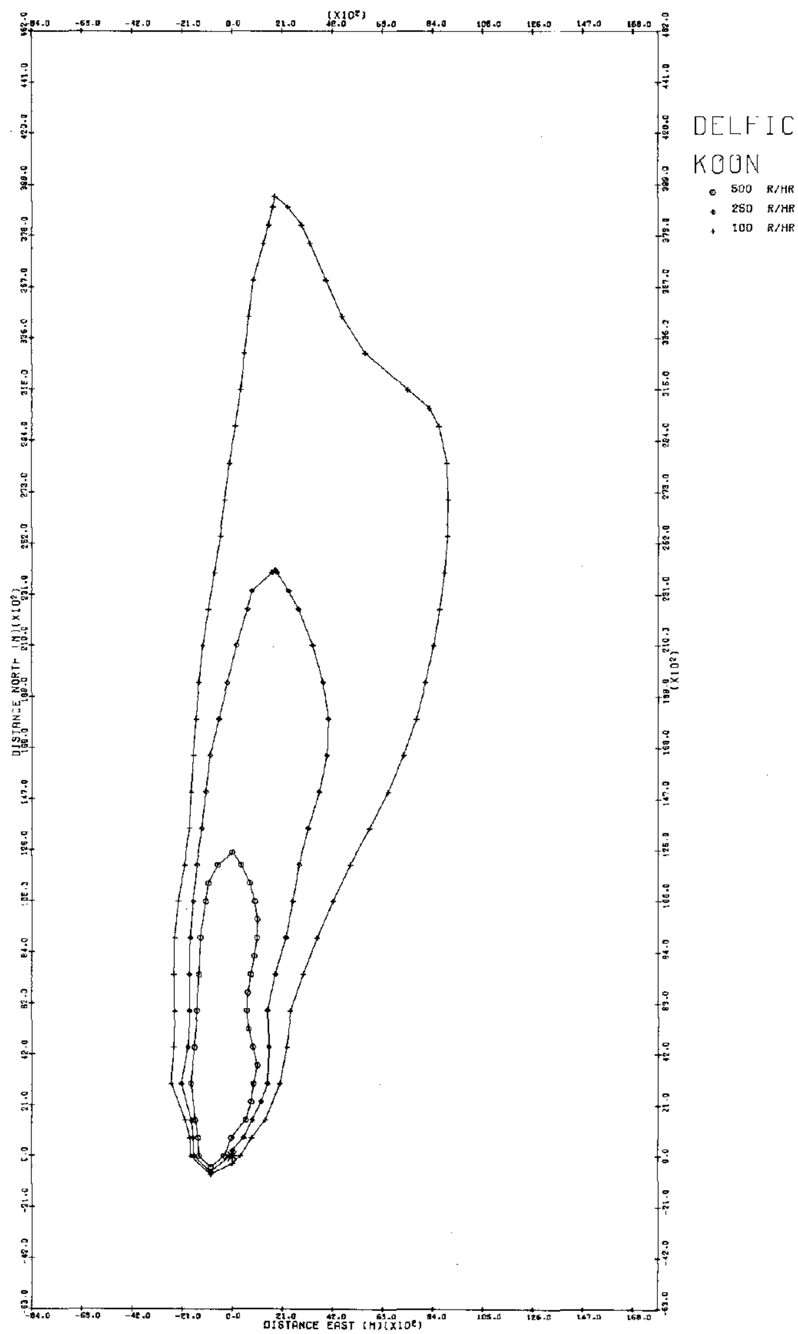
be superior to the patterns of the high yield shots which were executed on Bikini Atoll in the South Pacific. Not only are the fallout fields of the high yield shots very large, which adds to measurement problems, but most of the fallout from these shots fell into water. Even so, most of the Koon pattern area was covered by an array of fallout collection stations, so this pattern is probably reasonably accurate. Zuni, on the other hand, is a special case. The fallout pattern used here is exclusively downwind of the atoll and was determined by an oceanographic survey method that was known to be inaccurate. The close-in pattern in the region of the atoll is available, but contains no closed contours so could not be used here; thus the high-activity portion of the observed pattern for this shot is ignored, and this alone must account for a substantial portion of the disagreement between observation and prediction for this shot, particularly with regard to contour areas and contour overlap (Table 4). In addition, we have the following problem.

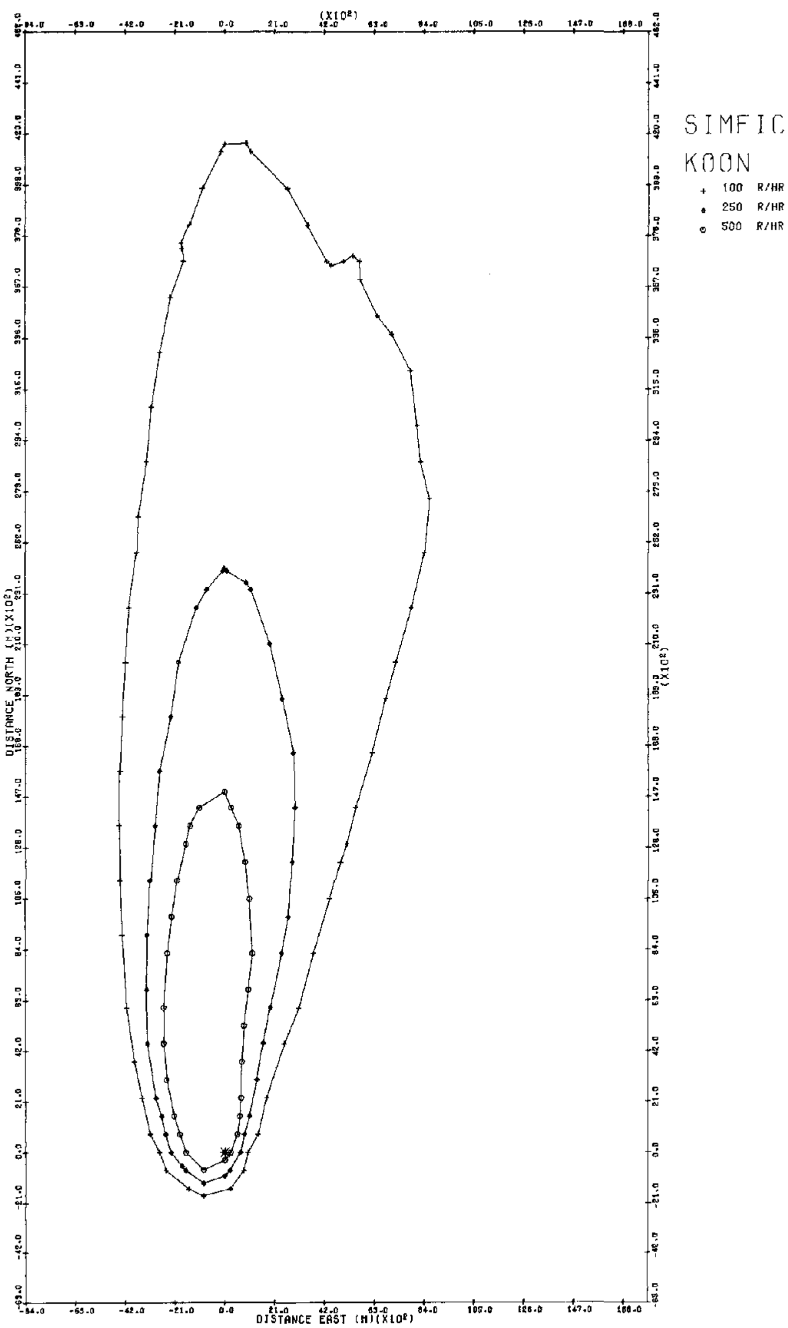
Predictions for these high yield shots are expected to be inferior to those for these low yield shots. This is because both of the high yield shots were detonated over coral soil, and in the case of Zuni, a large but uncertain amount of sea water was lifted by the cloud. The particle size distribution used for these predictions is typical of fallout produced from the siliceous soil found at the Nevada Test Site. We have not succeeded in developing a distribution appropriate for coral and coral-sea water mixtures.

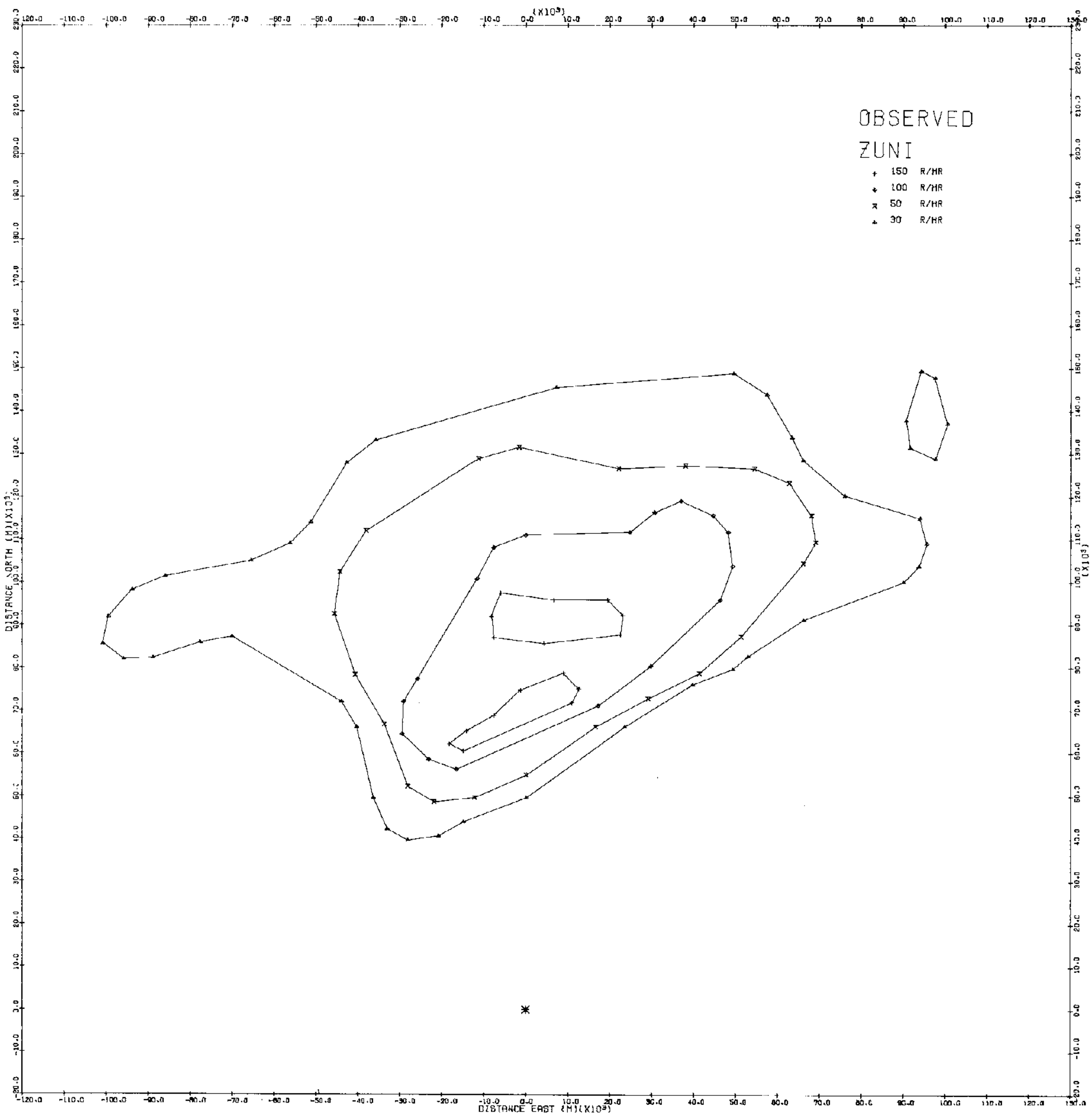
More details concerning the prediction calculations and test shot characteristics are in reference 7.

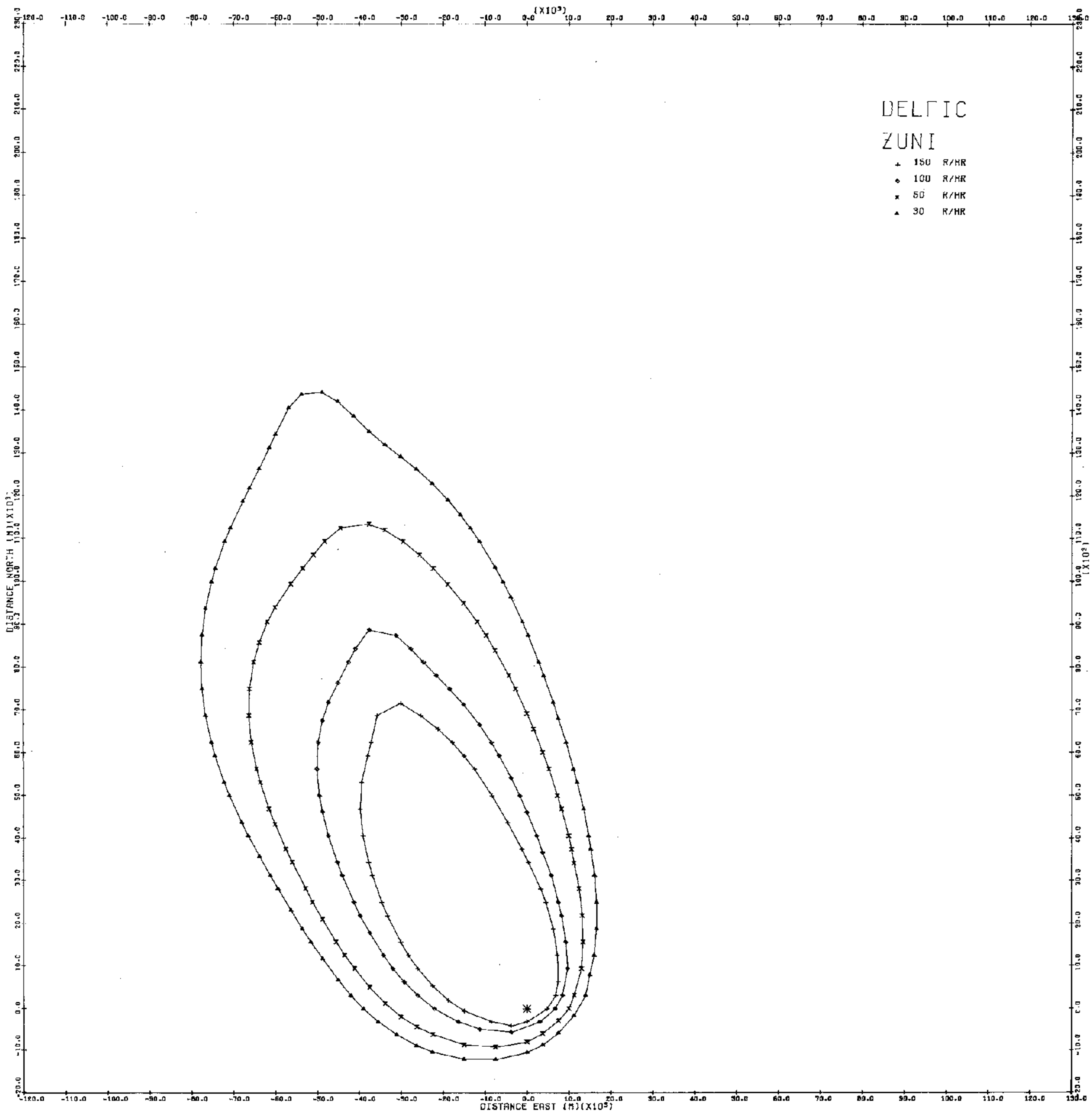


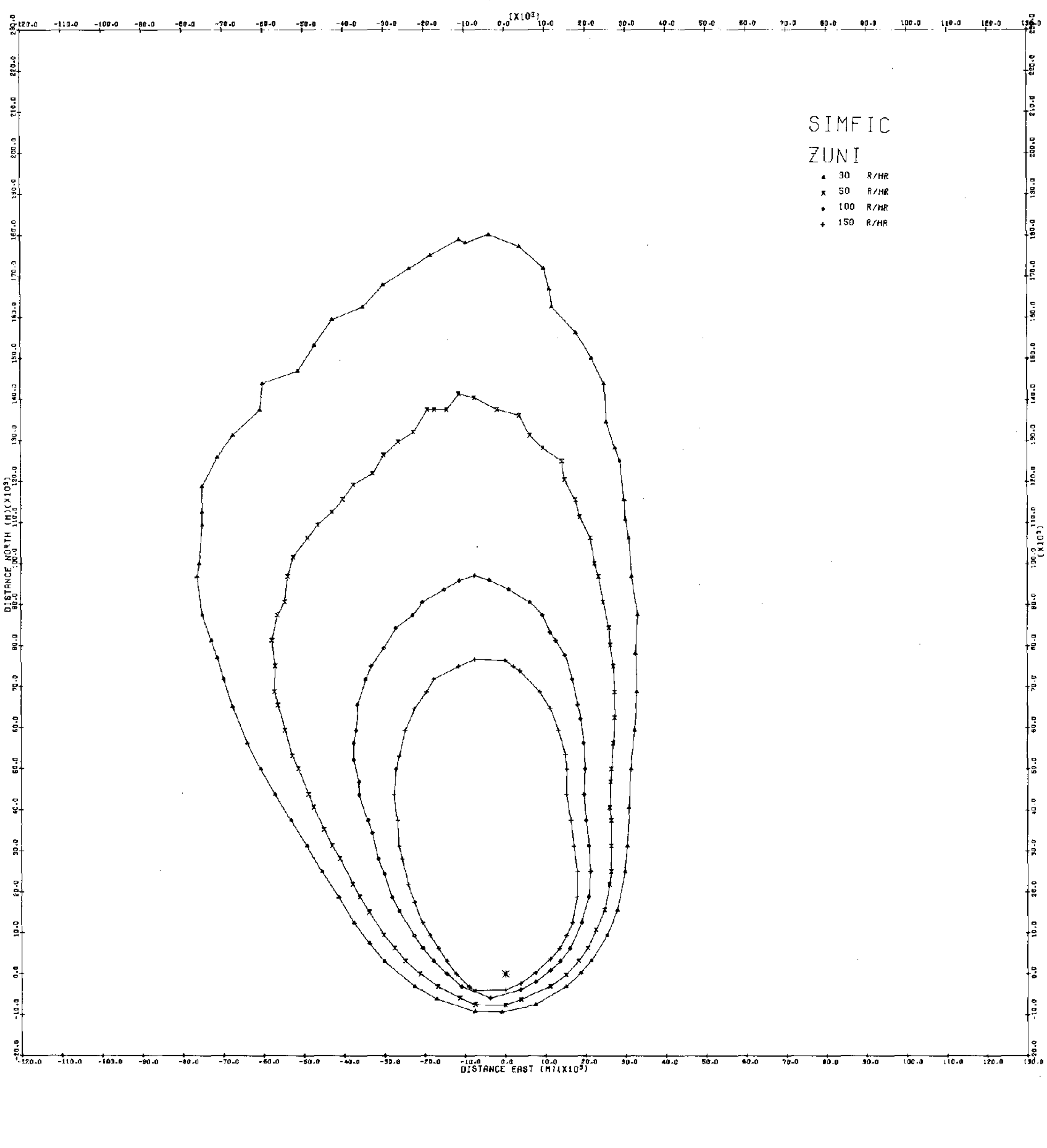
OBSERVED
KOON
100 R/HR
250 R/HR
500 R/HR
DISTANCE EAST (M)(X10²)
DISTANCE NORTH (M)(X10²)


DELFIC
KOON
500 R/HR
250 R/HR
100 R/HR
DISTANCE EAST (M)(X10²)
DISTANCE NORTH (M)(X10²)


SIMFIC
KOON
+ 100 R/HR
• 250 R/HR
⊙ 500 R/HR
DISTANCE NORTH (M)(X10²)
DISTANCE EAST (M)(X10²)


OBSERVED
ZUNI
150 R/HR
100 R/HR
50 R/HR
30 R/HR
DISTANCE EAST (M)(X10³)
DISTANCE NORTH (M)(X10³)


DELFIC
ZUNI
150 R/HR
100 R/HR
50 R/HR
30 R/HR
DISTANCE EAST (M)(X10³)
DISTANCE NORTH (M)(X10³)


SIMFIC
ZUNI
30 R/HR
50 R/HR
100 R/HR
150 R/HR
DISTANCE EAST (M)(X10³)
DISTANCE NORTH (M)(X10³)

REFERENCES

1. H. G. Norment, "DELFIC: Department of Defense Fallout Prediction System. Volume I - Fundamentals," Atmospheric Science Associates, DNA 5159-1 (26 October 1979).

2. H. G. Norment, "DELFIC: Department of Defense Fallout Prediction System. Volume II - User's Manual," Atmospheric Science Associates, DNA 5159-2 (26 October 1979).

3. G. E. Pugh and R. J. Galiano, "An Analytical Model for Close-In Operational-Type Studies," Weapons Systems Evaluation Group, WSEG RM No. 10 (15 October 1959). AD 261 752.

4. R. B. Mason, "Description of Mathematics for the Single Integrated Damage Analysis Capability (SIDAC)," National Military Command System Support Center, NMCSSC TM 15-73 (1 July 1973). AD 913 164L.

5. W. W. Kellogg, R. R. Rapp and S. M. Greenfield, "Close-In Fallout," J. Meteor. 14, 1 (1957).

6. H. G. Norment, "Analysis and Comparison of Fallout Prediction Models," Atmospheric Science Associates, unpublished.

7. H. G. Norment, "Evaluation of Three Fallout Prediction Models: DELFIC, SEER and WSEG-10," Atmospheric Science Associates, DNA 5285F (16 June 1978).

8. H. G. Norment and W. Woolf, "Studies of Nuclear Cloud Rise and Growth," Technical Operations, Inc., unpublished.

9. R. S. Scorer, "Experiments on Convection of Isolated Masses of Buoyant Fluid," J. Fluid Mech. 2, 583 (1957).

10. A. D. Anderson, "A Theory for Close-In Fallout from Land-Surface Nuclear Bursts," J. Meteor. 18, 431 (1961).

11. A. C. Best, "Empirical Formulae for the Terminal Velocity of Water Drops Falling Through the Atmosphere," Quart. J. Roy. Meteor. Soc. 76, 302 (1950.

12. K. V. Beard, "Terminal Velocity and Shape of Cloud and Precipitation Drops Aloft," J. Atm. Sci. 33, 851 (1976).

13. C. N. Davies, "Definitive Equations for the Fluid Resistance of Spheres," Proc. Phys. Soc. (London) 57, 259 (1945).

14. E. F. Wilsey and C. Crisco, "An Improved Method to Predict Nuclear Cloud Heights," Ballistics Research Laboratory, unpublished.

15. J. J. Walton, "Scale Dependent Diffusion," J. Appl. Meteor. 12, 547 (1973).

16. E. M. Wilkins, "Decay Rates for Turbulent Energy Throughout the Atmosphere," J. Atm. Sci. 20, 473 (1963).

17. R. L. Showers, "Improvements to the PROFET Fallout Prediction Program," Ballistics Research Laboratories, BRL-MR-2095 (February 1971). AD-883 280.

18. H. Lee, P. W. Wong and S. L. Brown, "SEER II: A New Damage Assessment Fallout Model," Stanford Research Institute, DNA 3008F (May 1972). AD-754 144.

19. R. H. Rowland and J. H. Thompson, "A Method for Comparing Fallout Patterns," DASIAC, G.E. - Tempo, DNA 2919F (April 1972).